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FIBROUS SUBSTANCES,

Indigenous and Exotic.

THEIR NATURE, VARIETIES, & TREATMENT

CONSIDERED.

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WITH A VIEW TO RENDER THEM FURTHER USEFUL FOR TEXTILE AND OTHER PURPOSES.

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a.

BY

S. L. SWAAB.

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FIBROUS SUBSTANCES,

&c.

The appropriation of nearly thirty years to the study of Botany, and especially to the nature and capabilities of fibrous substances, with an eye to their usefulness, has put me in possession of some knowledge, which will, I hope, be turned to a good account, in enabling me to introduce to higher manufacturing and commercial uses than hitherto, many of those productions of nature that present themselves in an almost illimitable degree in the tropical countries of both hemispheres, as well as those of the temperate zone.

The textile industries of the United Kingdom are of great national importance, and our dependence almost exclusively on one country for the supply of one of the raw materials, has recently thrown large numbers of the population into a state of enforced idleness, that must have been followed by utter destitution and death, but for the prompt and munificent aid extended to the sufferers by the more affluent classes of Great Britain and her dependencies.

That we could pass through such a crisis as that caused by the cotton famine with so little damage to either operatives or capitalists could never have been foreseen, but that the consequences will not all have ceased for many years to come is certain—if, indeed, they ever will. It is very doubtful whether the prices of cotton will ever again be as low as they were before the American War stopped its exportation from the Southern States, and even a small augmentation of price compared with the old scale cannot fail to limit the consumption, and proportionately to affect all the branches of industry in any way connected with its manufacture and trade. If this adverse contingency is escaped from, it must be by the introduction and use of other fibres as a partial substitute for cotton; and we have them in abundance, and of every variety.

I.—EUROPEAN FIBRES.

It was suggested by the *Times*, some eighteen months ago, that the linen fabrics which our forefathers wore, but which the American plant almost banished from the market, would, by the dearth and dearness of cotton, be again brought into use; but the comparatively high price of linen must always greatly restrict its use by even the middle classes of society, and place it quite beyond the reach of the poorer classes. There is, in fact, no proportion between the increased consumption of flax and the reduced consumption of cotton. And, indeed, how could there be? Cotton fabrics were in such great demand, because they were cheap, and therefore within the means of the great mass of the population, who were the chief consumers of them. Cotton goods have increased in the market price from 150 to 180 per cent., and in countless cases one gown or other garment must suffice instead of two or three. But linens are still higher in price than the dear calicoes, and are, therefore, even further out of reach of the mass of the community than cottons are. The consequence, as I have already suggested, is, that all suffer a loss—the people who wear clothing, the people who manufacture it, and the people who sell it, and all connected with them.

But why should we be confined to cotton and linen, and two or three other materials that are equally costly, for our lighter articles of clothing? These are not the only things that are fit, or might be made fit, to manufacture into comfortable clothing. Hitherto, cotton, flax, silk, wool, and two or three other substances, sparingly used, have constituted the sum total of the materials with which our wardrobes are furnished. But Providence has not so limited the supply of materials available for this purpose to six or seven—nor to 600 or 700. It is only our ignorance of the proper mode of rendering them fit for textile purposes, to which we have been reconciled by the abundant supply of cotton, that has hitherto induced us to overlook them altogether, or to be satisfied with them in a very rough and imperfect condition, and mostly fit only for very coarse and

inferior purposes. It is reasonable to think that this indifference to an almost unlimited source of comfort and wealth will not much longer exist. It is a question of the pocket —always one of interest to even those whose pockets are large and well filled, but much more so to the comparatively poor.

What an outcry there is if the Chancellor of the Exchequer, in the exigencies of the public revenue, puts on an additional twopence in the income-tax, and how great the satisfaction expressed when the flourishing condition of the finances enables him to take off a penny. In the former case the tax-payer whose income is £250 a year, say, will have to pay about £2 per annum more to the tax-collector; in the latter case he will have about £1 less to pay. Let these cases, respectively, be measured by the sum such person must annually pay through the increased price of the linendrapery worn in his family, even after reducing the frocks and gowns of the little ladies and their mother by one-half, greatly to the annoyance and discomfort of all. For a family of six the outlay for cotton goods alone can scarcely be less than £10 a year, according to present prices; and that is certainly more than double what they would cost if the prices were what they were five or six years ago. That is equal to an income-tax of nearly FIVEPENCE in the pound! Surely, if the public could see that the means of relief from such a burden were fairly within their reach, they would put forth their hand and lay hold upon them. Whether they will do anything towards bringing them within reach remains to be seen. That they may be so brought is undoubted, for the tropics in both hemispheres only await our call, to pour their illimitable stores of materials, quite as useful as either linen or cotton, into our docks and warehouses—and in such quantities as will make us look back to our supplies of cotton, large as they were, as something almost insignificant; and will furnish all classes, from the richest to the poorest, with fabrics, fine or coarse, costly or cheap, adapted to their position and means.

One cannot look at those immense quantities and varieties of fibrous substances which the tropics produce, and at the small use we have hitherto made of them, without something akin to wonder. The appropriation of fibre to the purposes of clothing is a very old invention; and the improvements which the moderns have made over the

ancients in the appropriation of it, is not calculated to induce us to think very complacently of the facility and thankfulness with which we improve the means Providence supplies us with for our comfort.

One of the earliest industries, after such as pertain to agriculture, is that connected with the clothing of mankind, by the conversion of vegetable substances into extended fabrics of various degrees of strength and fineness. Whether linen cloth was used in the construction of the antediluvian tents mentioned in the book of Genesis (ch. iv. 20, ix. 21, &c.), is not certain; but there can be no doubt that the coat of many colours which Jacob made for his favourite Joseph, as well as the robe with which the latter was invested, upon his elevation to office, by Pharaoh, was composed of woven fabrics, the material of which was flax. That this was extensively grown in Egypt in the time of Moses is certain, for the plague of hail is said to have destroyed the flax crop, the mention of which in connexion with the barley, shows it to have been of national importance. Indeed, the book of Job, which is believed to be the oldest book in the Bible, and to relate to a time preceding that of Abraham, mentions the weaver's shuttle as a familiar object (ch. vii. 6); and it has been ascertained, beyond all doubt, that the mummy-wrappers are made of linen. So that, at all events, linen was an article largely used by the Egyptians more than 3500 years ago; and it is worth noticing, that some of the mummy-cloths rival in their texture the finest cambric now made. We find, too (Ex. xxxviii. 9), that upon the departure of the Israelites from Egypt, they carried "fine twisted linen" with them. These circumstances lead to the inference, that the ancient Egyptians were in possession of some method of preparing the flax fibre which has long since been lost, although the use of the material has never been abandoned.

From Egypt, the Phœnicians or the Greek colonists probably introduced the culture of the plant into Europe. Homer alludes to its manufacture in Greece, and the Athenian and Roman marbles chronicle the mode of conducting the processes. The early traditions of Gaul and Germany frequently mention the flax; and there is reason to believe that there was scarcely any part of the European continent in which it was unknown, although its culture became, as a matter of course, chiefly confined to those countries within the temperate zone which are the most

favourable for its production—*i.e.*, between the 44th and 60th parallels of latitude.

We accordingly find that the margin of the ocean, from the southern extremity of the Iberian peninsula to a high northern latitude in that of Scandinavia, and the shores of the Baltic Sea, exactly indicate the *locale* of the great mass of flax husbandry; for there the soft western breezes, laden with the moisture from the sea, furnish that atmosphere in which the plant luxuriates. A considerable breadth of it is grown in Portugal and the Biscayan provinces of Spain; while French flax is almost confined to a belt accurately defining the littorial of the Atlantic, and rarely penetrating far inland, its chief seats being Gascony, Anjou, Vendée, Brittany, and Normandy. On the shores of the English Channel, the Belgian provinces of East and West Flanders, and Antwerp, comprise by far the greater proportion of that flax culture which has attained such celebrity; and following the coast line of Holland, the provinces of Zealand and Friesland are again the chief places of supply. On the German Ocean and the North Sea, Denmark and its Duchies, and the Scandinavian coast, still maintain their place; and, diverging into the Baltic, Hanover and Prussia, and the maritime Governments of Russia—Courland, Riga, Revel, Pskof, and Petersburg on the one side, and the Swedish and Finnish shores on the other—produce vast quantities of fibre for export; while vast fields of the plant wave on the shores of the White Sea, and, during the short midsummer, give life and activity to the commerce of Archangel, hermetically sealed during the rest of the year. The British Isles are the outlyers of this flax zone—Ireland chiefly sustaining the character; while in England, the culture, which had dwindled into insignificance, exhibits some symptoms of a revival. That the United Kingdom should maintain a high place among the flax-producing countries of the world is certain; for its insular position, and its consequent large share of the watery tribute of the Atlantic, peculiarly adapt it for the culture of the plant.

Of the quantities of flax fibre produced by these various countries, we can get only at an approximation. The most carefully compiled statistics give them at from 450,000 to 470,000 tons a year. Taking the lowest estimate, and valuing the fibre at £50 per ton, the proceeds will be £22,500,000; and if we assume that the fibre enters to the extent of one-third into the value of the

fabrics manufactured, the total annual value of these may be set down as exceeding £70,000,000 sterling.

The quantity of flax imported into this country in 1862, was nearly 90,000 tons, as against about 70,000 tons of our own production; so that we are sending more money abroad for this article of increasing consumption than we are spending at home, and that chiefly for descriptions of fibre with which our own can most favourably compete, both as to quality and price—a circumstance without any good reason, seeing that we might easily double the produce of the United Kingdom, at a great and immediate profit to farmers and landowners, and to many others besides.

The flax imported from different countries differs considerably in quality. In the polders of Holland, the artificially enriched lands of Belgium, the vegetable mould of the Bocages, the peat of Connaught, the limestone of Central Ireland, and the clay slate of Ulster—in all these soils excellent flax is grown; but the soil most congenial to it is furnished by the alluvial deposit of rivers. Holland and Belgium, composed of the alluvium brought down by the Rhine, the Scheldt, and the Meuse; the rich lands on the banks of the Irish rivers; the valley of the Nile; the shores of the Oder, the Vistula, the Niemen, and the Dwina are the deposits peculiarly suited to the growth of this important vegetable.

Russia takes the lead, at a long distance, of all other countries in the production of flax, although it is not of the best quality. Of the importations of the fibre into this country about 75 per cent. of it comes from thence; but, like the fibre from Egypt, it is used only in the manufacture of coarse fabrics, such as sail-cloth and bagging. The Dutch, Flemish, French, and Courtrai flaxes are made into all the finer kinds of linen, cambric, lawn, and damask; while our native flax, furnishes, with the Dutch, the chief material for medium qualities, an increasing proportion of it being suited for the finest kinds; and the proportion may be largely augmented by improved methods of treating the grass. Belgium has long been considered unapproachable in the quality of her fibres, which are an important source of income to that little state. Their extreme fineness, softness, and lustre render them highly valuable, their market price varying from £70 to £140 or £160 per ton—the Courtrai being the most valuable, in consequence of the river Lys,

in which it is steeped, possessing peculiar properties for its fermentation. It should not be overlooked, however, that the Belgian farmers pay great attention and bestow great care on the cultivation of the plant, which produces them large profits. The fibre for the manufacture of lace has especial care given to it. The most thoroughly pulverized soil being chosen, the seed is sown about double the usual thickness, and every weed is from time to time carefully plucked up. Branches and stakes are fixed in the ground, with lines intersecting, like the meshes of a net, in order that the fine stems of the flax as they come up may be supported against the high winds and heavy showers to which they are exposed. The farmer, however, is well paid for his labour, from £40 to £60 per acre being a common return, and from £80 to £100 being sometimes obtained. Leeds and Belfast take large quantities of the Belgian flax, the spinners sending their buyers over to select the flax on the spot.

The comparatively small quantity of flax grown in the United Kingdom must appear a strange thing to all who look at it, and who know how well the climate and much of the soil are adapted to its growth; as also how profitable its culture may be made to the farmers. More attention has been given to it in both England and Ireland during the last few years—especially in the latter country, where efforts are still being made, and not without success, to extend its growth, as the following statement of the number of acres under flax cultivation in the several years named will show:—

1859	136,282 acres
1860	128,595 „
1861	147,957 „
1862	150,070 „
1863	214,092 „

In the last of these years, the province of Ulster had 207,345 acres of flax to itself, thus leaving only 6747 acres for the rest of the country, which shows how much work remains to be done by those who are exerting themselves to extend the culture of this valuable fibre in that part of the United Kingdom. Indeed, there is no doubt that the whole quantity of land now under flax crops in Ireland might well be doubled, if not trebled, greatly to the benefit of all classes—landowners, occupiers, labourers, artisans,

and manufacturers; and to effect this should occupy the attention and command the aid of all who have the means of promoting it. Assuming the average yield to be 5 cwt. per statute acre, 400,000 acres would yield 100,000 tons, which, at only £50 per ton, would produce £5,000,000 sterling. The produce in 1863 was only about £2,700,000. It is obvious to ask, too, why Ireland should import from foreign countries some 8,000 or 10,000 tons of flax a year? At the average value of £60 per ton, this takes from that part of the kingdom no less than from £480,000 to £600,000 a year, by far the greater part of which ought to be kept for distribution among the Irish people themselves.

For the rest of the United Kingdom—that is, England and Scotland—the flax produce is miserably small, not more probably than from 16,000 to 18,000 tons.

There must be some special reason or reasons for this neglect of a profitable branch of industry in the United Kingdom, in which the demand for the article is so large, and the number of people living upon exceedingly small incomes—especially in Ireland—is always so great.

Mr. Warne, of Trimingham, in Norfolk—one of those sensible farmers, who, instead of sitting down in despair, when the British markets were thrown open to the importation of foreign-grown corn, intelligently looked around and ahead, to see in what way best to increase the produce of his land, so that he might thus make up for the loss of the artificial prices he had previously obtained—says he should have despaired for himself had his land not been capable of raising other crops than those of corn, grass, and turnips. Forty years' experience as an agriculturist, however, gave him a comfortable persuasion of successfully competing with foreign importations. How was this? His farm is upon the sea-coast, at the extreme north-eastern part of the county, and the soil is, generally speaking, of an inferior quality. What were the circumstances, then, that inspired him with confidence? He thus states them:—"The Trimingham system of agriculture rests upon the growth of flax, and the fattening of cattle in boxes upon the seed, incorporated with other produce of the farm, both summer and winter;" and wherever that system is adopted, it will, he is satisfied, render the farmer independent of foreign cattle, food, and manure, and secure, in addition, the following benefits:—It will provide for the maintenance, upon the same space,

of double or treble the number of cattle usually kept; keep the land in a profitable state of productiveness; prevent the possibility of deterioration; afford employment for both sexes, of all ages; increase the consumption of food and clothing; circulate wages, and lessen rates; prevent crime; promote industry, frugality, and contentment; and, lastly, enable the occupier to become a good tenant, as well as a benefactor to his country.*

This is no idle speculation, but the result of a practical farmer's own experience; and the great benefits which his mode of farming, that makes flax one of his regular crops, brings to the cultivator are very fairly enumerated. His pamphlet, referred to below, will repay the careful reading and study of all who, like him, devote themselves to agricultural industry. It contains much valuable practical information.

How immediately the interests of the owners as well as of the occupiers of land, as, indeed, of all classes of the community, are more or less involved in the extension of this branch of husbandry must be evident to all who have looked at the subject; and yet, those most interested have hitherto, to a large extent, shut their eyes against it.

The chief reasons for this are two.

In the first place, there has been a very general impression amongst both landlords and tenants, that flax is a very exhaustive crop, and greatly injures the soil. Once in five or six years has generally been thought to be as often as the land could be properly devoted to a crop; and it is not much to be wondered at, therefore, that farmers in general should not have paid much attention to it.

Now, it is not to be denied that the method of treating flax-grass, hitherto almost universally obtaining—*i.e.*, by retting—has given a good deal of reason for the prejudice entertained against frequent crops of flax being raised upon the same land. Flax no doubt abstracts from the ground a large proportion of nitrogen, and thus exhausts it of its fertilizing quality; but let a method of obtaining the fibre be discovered, which shall retain the substances detached from it, and the ground may be saved from all the deterioration complained of. In the case of ordinary food substances, the seed alone is removed, and in all good husbandry the constituents of the straw or stem which fur-

* "Flax *versus* Cotton." Published by Ridgway.

nished the seed is again restored to the soil. If the land upon which the flax crop has been produced could thus be dealt with, it would suffer no more under this than under any other crop. It is an ascertained fact, that those portions of the flax stem which are required for the purposes of manufacture are obtained almost exclusively from the atmosphere. Analysis has demonstrated that 100 lbs. of the fibre do not contain on an average more than 2 lbs. of mineral matter; and the restoration of the steep-waters and of the woody portions of the plant, with the husks of the seed, to the soil, will completely renovate the land, and make it as fit to produce a crop as it was before. In point of fact, flax, if properly managed, tends greatly to improve the soil and the character of the other crops in rotation. Lord Monteagle states that the growth of flax has greatly improved some poor land on his estate, and that no meadow yields such excellent grass.

That the culture of flax is, even under the present imperfect system, profitable to the growers is certain. From the particulars given of the flax crops of fifty-one farmers in the county of Down, as published in a Report of the Royal Irish Flax Society, it appears that the average profit from the fibre, only, was £7. 1s. 4½d. per acre. In no case was the seed saved; but another grower, who saved both seed and fibre, showed that he made a profit of £6 per acre above what a wheat crop would have yielded. It need not be remarked, that a cheaper and more productive method of preparing the flax grass for market would proportionately increase the profit of the grower.

The other thing that has restricted the culture of flax in the United Kingdom, is the necessity under which the grower has hitherto almost universally been placed, of having to undertake a very unpleasant, and in most respects unsatisfactory, series of operations before he can send his flax to market. He has to separate the fibre from the glutinous and the woody matter to which it is attached, in most cases by a process which converts the pure and healthy atmosphere in which he generally lives into one of a most noxious description, and which, at the same time, interrupts more or less the ordinary operations of the farm. When the flax is taken out of the ground, instead of being at once sent to market, or stacked until it is required, it has to be put through a process of fermentation or incipient putrefaction for two or three weeks, during which time, as

also after it is spread out to dry, a large quantity of putrid vapours are given off. The water and the very air itself are poisoned, as well as all the ponds and ditches into which the water that has been used finds its way. So serious have these putrid exhálations been found, that water-retting has long been forbidden in some parts of Belgium, Hainault, Namur, and elsewhere; and here, the local Boards of Health interfere to suppress the nuisance. As long ago as the reign of Henry VIII. an Act was passed prohibiting the steeping of hemp or flax in any running stream; and it is still in operation.

But in addition to this noxious attendant upon the retting of the flax, which is quite bad enough in itself to deter many farmers from cultivating the plant, there are other circumstances that are scarcely less operative in their influences. The flax-grower, when he gathers his crop, must leave, to some extent at least, his regular work of husbandry, and turn manufacturer.

M. Delamer, in his useful little book on the culture and manipulation of flax and hemp, has not failed to advert to this circumstance. The English farmer, he observes, has too many little details to attend to *after* the flax is grown. It is more than he can manage himself, with all his other complicated affairs. To grow flax and then prepare it for sending in a proper state to the spinners, he has to educate a set of men and women to execute a series of nice and tedious works which they have never seen before, and of which they have not the slightest idea; and after he has done his best, he will sometimes find that his crop has been so far injured in the processes it has gone through, that he is probably left a loser when he effects a sale. This is consequent, not only on the want of skill in the manipulations, however; it results in some considerable degree from the many contingencies on which the success of the operations depends. There is, first, the securing of retting-pits or pools that are suited to the purpose. It is not always that a running stream is at hand, and if there were, it is seldom that a farmer would be permitted to poison it with his stinking putrefaction. Natural stagnant water is not the thing; to be made such, it must be gently renewed, by a stream entering at one end of it and escaping at the other. Then a good deal depends upon the quality of the water, as we know by the Belgian flax, rendered so beautiful by steeping in the river Lys. The water for steeping must be

free from all mineral substances, and should be kept alive, so to speak, by a gentle stream always passing over it, to carry away the impurities, but without disturbing the fermenting process. After some considerable experience, Mr. Warne, to whom I have already referred, says that in future he shall send his best flax to any distance where he can find a suitable place for *retting*, rather than risk its value at home. This is all very well for the farmer who has a large farm and an adequate capital, but the farmer of small means can resort to no such expedient.

But suppose the grower to have provided himself with suitable pools, and a proper supply of congenial water, even then his chances of failure are not all past. The flax is still subject to injury. The time during which the grass should remain in the steep is a nice thing to determine. It cannot be fixed, as it will vary with the temperature of the atmosphere, the quality of the water, and the texture of the grass. Nevertheless, it must be so measured as to be long enough to ensure the decomposition of the glutinous matter, but not enough to cause any injury to the fibre. A slight change of temperature, or a few hours' exposure after the fermentation is complete, may produce disastrous results, in the ruin of the fibre. These can only be guarded against by carefully watching the steeps towards the close of the slow, tedious, and very uncertain process—a thing that can scarcely be expected from those who are engaged probably for the first time in the work, or, at the most, are engaged in it but very seldom. Even, without this advantage, the chance of damage, especially by prolonging the steeping beyond the exact time, is considerable. Messrs. Marshall and Co., the eminent flax dressers and spinners of Leeds, state that the chief difficulty in retting the flax is to decide the exact time when it should be taken out of the water. This, they add, is a very nice point, as by allowing it to remain in the water two hours too long it may be over-retted; and so nice a discrimination and so careful and experienced a vigilance is necessary, that they recommend that persons should be sent abroad to study the process; or, if that cannot be done, a Belgian, they say, should be employed to superintend it. The advice may be very well for those who have at command the means of adopting it; but to some, it will be like the Queen of France's notion—That if the poor could not get bread they should eat cakes.

These impediments in the way of the growth of flax, or rather in the preparing of it for market, after it has been grown, have engaged much of the attention of manufacturers and others; and various means for shortening the steeping process, getting rid of the noxious effluvia, and ensuring more certain results have been brought forward; and scores of them have been patented, found to be worthless, and are now thrown aside. Some inventions have been purely mechanical, neither water nor steam being used; but after passing through various alterations during the last three-quarters of a century, this mode of treating the dried straw has been found to be fit for only very inferior uses. The chemical inventions to supersede the primitive method of steeping have been many; but the large use of alkalies and acids which they mostly include is extremely injurious to the fibre.

Schencke's process, known as the hot-water steep, and introduced into Europe in 1847, was well spoken of, and, as many believed, promised to supply the long-wished-for desideratum. It was to promote fermentation by the use of water at 80°, or a higher temperature; but it was soon objected to its use, that the same kind of offensive gaseous exhalations were given off during the process as in the ordinary method of retting; that the fibre was weakened when overheated; and that, in the process of scutching, the scutchers could not bear the smell of the irritant dust which flew off. In Ireland, great expectations were entertained as to its results; but, as the *Journal of the Chemico-Agricultural Society of Ulster* (Jan. 1853) observes, "The establishments erected under Schencke's patent have not, generally, given satisfaction;" and, as the jury on the raw materials used in manufactures, who reported to the Commissioners of the International Exhibition of 1851, say, "It is far from removing all the difficulties of the flax manufacture; much still remains to be effected."

Schencke was followed by Watts, whose system combines the use of steam and hot water—the one to soften the component parts of the stem, the other to wash out the fibre. Buchanan's method sets aside one of Watts's two agents; while Pownall and Hays add another agent to them, in the form of a roller, which is said to be necessary in order to free the fibres from the deposit of decomposed gum found on them after the steaming and washing.

How far any one of these methods of treating the plant

was from meeting all the requirements of the case, was soon discovered; and in 1854, M. Paul Garavaglia de Soresina obtained a patent for improvements in the treatment of flax and hemp, the process he adopted being as follows:—The flax or hemp, after the seed and roots have been removed, is sorted and scutched, and the ends somewhat opened by heckling. Quantities or bundles are to be slightly twisted, and then to be placed on the false perforated bottom of a strong vat or vessel, and successive layers of such twisted bundles or quantities are to be placed one over the other. The vat or vessel is then to be closed. The flax or hemp is next to be subjected to the percolation of water through it, till it flows from the vessel clear. The water used in this process is to be perfectly clean, and to enter under the pressure of a column 32 feet in height. The flax or hemp is then subjected to pressure (by preference, hydraulic pressure), to separate the water. The flax or hemp is then to be dried by the heat of the sun, or in a warmed room or chamber. When dry, the flax or hemp is to be subjected to the action of a grooved roller, moved over it when on a groved table. The flax or hemp is then to be again twisted, in quantities, but in the opposite direction, and be placed again in a vat or vessel, and be subjected to the percolation of cold water, under pressure, as before, until the water flows off clear. It is then to be pressed and dried as before. After this, it is to be twisted in the same direction as at first, and be placed in a strong vat or vessel, with a false perforated bottom, and be subjected to the action of steam, at pressure, and to hot water, until the water comes off clear. The flax or hemp is then to be pressed and dried, and the fibres laid straight, when it will be complete for the market, or to be further manipulated as heretofore.

It is not to be wondered at, that a process, or, rather, a series of processes, requiring so much time and labour, and involving so many risks of damage to the fibres themselves, should have been thought still to leave a shorter and less expensive method possible. Accordingly, in 1857, Mr. Henry Johnson took out a patent for "an improved mode of treating flax and other similar fibrous substances, whereby the old and injurious process of retting is dispensed with; and the total removal of the gummy or resinous matters contained in the flax, or other similar fibrous material, is effectually accomplished, with a great

economy of time and labour, whilst the texture of the fibres is greatly improved, and a considerable reduction in the waste of the material effected. Secondly, for an improved mode of effecting the perfect division or separation of the fibres after they have been freed from the gummy or resinous matters."

Nothing could be better than the description of the object to be accomplished. Let us now see the means to be used for that purpose. After about 20 lbs. of flax, or, &c., has been freed, as much as possible [?], from its straw or woody matters [how ?], it is to be boiled for about two hours in 74 gallons of water, wherein about 3 lbs. of simple crystallized or calcined soda have been dissolved. The fibrous substances having been then removed from the boiler, and well wrung, so as to remove the greater portion of the solution therefrom, are to be placed for 50 or 60 minutes in about 35 gallons of water, with which about 4½ gallons of sulphuric acid have been previously mixed, after which they are to be well rinsed in cold water, and then to be well pressed. The material is then to be dried by a moderate heat, and the fibres to be separated by mechanical or other ordinary means. The fibrous material is next to be placed, for about half an hour, in about 39 gallons of water, in which about 3½ lbs. of bicarbonate of soda have been dissolved. It is then to be withdrawn, and the surplus liquid to be expelled by compressing the material lightly. It is then to be immersed, for 10 or 15 minutes, in about 35 gallons of water, with which about a pint and a half of sulphuric acid has been mixed; and, after washing, rinsing, and drying, it will have been completed.

Here the process is as dilatory, as inconvenient, and as expensive as M. Soresina's process, and still more injurious to the fibre.

M. Alcan, Reporter of the Jury on Class XIX., in the Exhibition of 1862, has noticed a circumstance that should not be lost upon us—*i.e.*, that the manufactures from flax and hemp in the United Kingdom are far from increasing in the same proportions as other branches of textile manufacture; and he attributes the circumstance, in a considerable degree, to the comparative imperfection of the fibre as left by the present methods employed to purify and soften it. "The great fault in the flax-fibre," he observes, "is the excessive quantity of gum which is not extracted by the present steeping process. When a new process

shall be discovered," he adds, "to remove completely this objection, there is no reason why flax-fibre should not be spun as easily and as fine as cotton. It is to be hoped, also," he thinks, "that by such improvement, we may eventually obtain a class of yarns more elastic, and that the cloth made from them may weave more readily, and, in the end, give greater satisfaction and durability." Passing from the flax-fibre to that of hemp, and other similar substances, he notices that the hemp is inferior to flax in softness and minuteness of subdivision, making it more difficult to spin; and that China grass has the same defect in a much higher degree, while it is also much more costly.

All this is no doubt true, and M. Alcan is probably right in anticipating that through the great attention now being given to the flax-steeping process, and, in consequence, to the real cause of the deficiency of the fibre for the spinning process, we may obtain such improvements as are made in other branches of industry. He looks to the Belgian process of Lefebvre as constituting an important step towards a more perfect and rational mode than any hitherto known. Had he looked into a case of specimens, many in number (Class IV., 1135), including European hemp and flax, as well as China grass and other Indian fibres, I think he would have found what he seems to have been looking for, without going so far as Belgium for it.

The many patented processes that have since been introduced—none of which are sufficiently simple, economical, and sure in their results to commend them to general adoption—show that we are still in want of a method of preparing the flax for spinning which shall combine simplicity, expedition, economy, and certainty, and which shall, moreover, ensure the largest quantity and the greatest strength of fibre that can be got out of the grass; while it is so easy to be used, and so readily to be placed on any spot of land without detriment or annoyance to anything or to anybody in the neighbourhood, that either the smallest or the largest grower may use it.

I venture to say that I have discovered such a method of relieving the flax-grower from his annoyances, and of obtaining a much larger quantity and a much finer description of fibre than has ever yet been obtained. It separates the fibre from the wood and gluten, in the course of a short time, without producing the slightest offensive smell either

during or after the operation; retains all the original strength of the fibre, and gains from 50 to 70 per cent. of it upon any method hitherto known. I may add, that any person who is familiar with the various European flaxes used in this country, will see, upon examining numerous specimens treated under this process, that great differences in the quality, hitherto attributed mainly to the soil and climate in which the flax is grown, are really attributable—in considerable part, at least—to impurities left by the dressing in those that are of inferior quality.

Mr. Warne having called public attention to the subject of flax culture by a letter in the *Times*, in January, 1850, George Mason, Esq., of Yately, Hants, availed himself of the opportunity its appearance afforded to press the subject still further on the attention of farmers, through the columns of the *Hampshire Chronicle;* and though his realized profits on a crop of flax were not so large as those obtained by Mr. Warne (stated at £9 per acre, on 14 acres), they were such as to satisfy him that the growing of flax might be turned to good account upon almost any farm, even under the disadvantages now attendant on preparing it for market. His first crop, he says, sold at Leeds at £46 per ton, and left him a net profit of something more than £4 per acre, including seed and tow, after deducting rent, rates, seed, labour, and expenses of sale. Captain Mason's profits were reduced, it should be observed, by the heavy expenses of carriage to Leeds, and loss of labour, as well as by the inferiority of the fibre, he being then in his noviciate. He has since done much better, I know, having both economized his labour and produced better flax. He sent some good specimens to the Exhibition of 1862, to show the result of his efforts to introduce the culture of the plant into Hampshire, with a view to the giving of employment to the children of the poor.

The exertions of these two gentlemen should operate as a stimulus to landowners and farmers in other parts of the kingdom. In Ireland, flax is realizing between £35 and £40 an acre; and more care in its cultivation, and a cheaper, and a more expeditious and effective system of detaching the fibre from the wood and releasing it from the gummy matter attached to it, would of course at once reduce the cost of production and bring higher prices.

There can be no doubt that the extension of flax culture in the United Kingdom, in anything like a pro-

portion to the demands for the article, would contribute greatly not only to the profits of the farmers, but to the remunerative employment and therefore comfort and happiness of the labourers. In raising 20 acres of flax, Mr. Warne expended £140 in wages, a good deal of which was received by lads and women; and the consequences of introducing this culture into the parish of Trimingham were thus described in the *Morning Chronicle* of the 22nd of December, 1849, by a gentleman who had visited the place and had instituted all necessary inquiries. "The condition of the inhabitants was, a few years since, deplorable, and the amount of pauperism exceeded that of the adjoining parishes. Since the introduction of flax, however, this state of things has passed away. The poor-rates are nominal, and the cottage accommodation is ample and of excellent character. Previously, little or no employment was provided for the weaker hands; now, both old and young find abundance. The money thus circulated amongst children augments their parents' wages, and thereby large as well as small families derive ample maintenance. The moral and physical state of the village will bear comparison with most. Not an instance of illegitimacy has occurred for many years, nor a conviction for theft. The children, educated at a school unsupported by church or state, are trained to habits of industry through flax-dressing, and early find situations at service." And the writer, after mentioning several cases in which families had been recovered from the workhouse, and made comfortable in their circumstances through the wages earned on the flax, adds: "There is now no able-bodied labourer, nor any portion of his family who may not obtain employment throughout the whole of the winter months in scutching and preparing the flax for market. . . . On the occasion of my visit to the farm, the weather was such as totally to preclude the possibility of carrying on any field labour. The snow had been upon the ground for many days previously, a thaw had set in, and with it a constant and heavy fall of rain. The men employed upon the farm were not sent home, but, on the contrary, were all busily engaged in the barn, in beetling the flax; while, upon another portion of the premises, fourteen persons, some of whom were children, were employed in scutching it."

I quote this extract, in the hope that it may receive attention from all who are immediately or mediately inte-

rested in extending the remunerative employment of the poorer portion of the population. If flax were made one of the usual rotary crops on a farm, throughout the kingdom, all would be benefited; for, while the farmer and his labourers reaped the immediate advantages, other and more productive processes of dressing the flax for market would so affect its price as to make linen fabrics as cheap, at least, as cotton are ever likely to be.

Europe produces many other substances than flax, which yield a fibre more or less adapted for textile purposes, if it were but properly treated; but of these hemp is almost the only one that has been thus used to any considerable extent. The Russia hempen cloth is of great durability, but it is too coarse and harsh to come into general use, though sometimes used for sheeting. The peasantry of Russia wear shirts of hempen cloth, when they can get that garment, and I believe hempen shirts are still worn by some of the peasants or agricultural labourers in England. Hemp finds a congenial soil in most parts of the world, but it is to Russia chiefly that we look for large supplies. The European provinces produce about 2,200,000 cwt. a year.

I do not know whether the flax of the Thracians was inferior or their hemp superior, but Herodotus tells us that they made clothing of hemp very like linen cloth; nor could any person, he adds (B. iv., 74), without being very well acquainted with the substance, say whether it was made of hemp or flax. A person who had never seen hempen cloth would, he thinks, inevitably suppose that of which he was speaking to be made of flax.

Of the samples of hemp contributed to the International Exhibition, those from Italy, Flanders, and Spain were, I believe, the finest; but the imperfect manner in which the fibre of the plant has hitherto been freed from the extraneous substances with which it is laden, confines the use of it chiefly to the manufacture of canvas, ropes, cords, mats, and other coarse articles; and for even some of these the imperfect treatment of the fibre renders it in some degree unfit.

That the use of hemp might be greatly extended, and that it might also be made to produce cloth greatly superior in strength and durability to much of that manufactured from flax is certain. I have made many experiments upon even the coarser hemps of Russia, and have reduced they

to a condition which fits them for any textile purpose; their texture and strength being equal to those of good English or Irish flax.

We obtain the great bulk of our hemp from Russia, although English hemp, if properly manufactured, is in all respects greatly superior to it. Its cultivation here, however, is inconsiderable, and it is not likely that it will ever make much progress. The return it yields is not a sufficient compensation for the trouble and annoyance connected with preparing it for market after it is taken out of the ground; and, further, there are many tropical fibres which will, in all probability, now that better and cheaper methods of preparing them are discovered, supersede its use for all but very rough purposes.

It is to the tropical regions, however, as I have already suggested, that we must look for large additions to our textile materials.

II.—TROPICAL FIBRES.

The Eastern hemisphere produces a large variety of exogenous plants, the fibres of which are extremely diversified in quality, but most of them capable of being brought into a condition of great usefulness, some being of a very fine and beautiful description; while the Western tropics teem with endogens, whose fibres, if not equal in beauty or so well adapted for textile purposes as the exogens of the East, furnish abundant material of great strength and durability, and are therefore admirably adapted for the manufacture of rope and cordage, and of canvas and coarse cloth, of almost all kinds. In point of fact, almost every plant in the tropical regions contains more or less of fibre, although but comparatively little of it has yet been brought into use, in consequence of our not knowing how properly to separate it from its parent stem and from that glutinous resin by which it is naturally attached to it. There are, I believe, as many as three hundred and fifty or four hundred patented processes said to be adapted to the purpose, and they are being added to almost daily—a circumstance which indicates pretty plainly that we are still deprived of much of the material of comfort and wealth which Nature has placed within our reach.

Before I notice more particularly such of these fibrous substances as are more particularly worthy the notice of the manufacturing and commercial classes of the community, as being the best adapted for finer or more delicate uses—such as clothing, paper, &c,—it may be well to remark, that botanists arrange plants under two great divisions, based on the different manner in which their fibrous portions are deposited. All fibres are modifications of single cells, and the diversities presented in the natural structure of the stem are owing to the different mode in which the fibres or longitudinal portions are added to its substance. In exogens, these additions are made in regular layers on the outside of the central pith or the wood last formed, and in annuals remain flexible, as in flax and hemp, while in perennials they become woody, as in the palm-tree. In endogens, the fibres are deposited from within, where the fresh deposits intermingle to some extent with the older ones. Hence it is that there is much more irregularity in the fibres of endogens than in those of exogens.

There is another class of fibres of a different description altogether—such as cotton and coir—which are produced in connexion with the seed and the fruit, and not with the stem or leaves of the plant.

Of the fibrous productions of the Western world, Mr. Squier, formerly Minister of the United States in Central America, has recently published a very interesting account,* which shows, as he observes, that the tropics of the western hemisphere furnish their full share of these useful objects of nature.

Of the *endogens*, which furnish the most valuable fibres, there may be mentioned the several families of the *Agave* or amaryllis, the *Bromelia* or pine-apple, the *Musa* or plantain, the *Yucca* or lily, and the *Palmetto* or palm.

Of the *exogens* may be noticed the families of the *Urtica* or nettle, the *Malva* or mallow, and the *Tilia* or lime.

The Agave or Amaryllis family produces excellent fibres in great abundance, and is spread very plentifully over a broad belt of at least 33° on each side of the equator, from Virginia on the north to Paraguay on the south, as well as in the East and West Indies. The *Agave Sisilana* produces the *Sisal hemp* of commerce, known also as *grass*

* Published by Madden, Leadenhall Street.

hemp. Dr. Perrine, late Consul of the United States in Yucatan, called the attention of his Government to the value of the fibre which the natives get in their rough and primitive way from this plant. He says: "I beg the department to reflect on the fact, that the very strong, light, durable fibres of this plant, extracted from the fresh leaves by simple scraping, are immediately converted into cheap cloth for bagging, &c., without spinning, twisting, or any intermediate preparation or fabrication whatever. By the quadruple properties united in the single untwisted, foliaceous fibres of the *hennequin* (the name given to the plant in Yucatan), they become a superior substitute for the compound, twisted, cortical fibres of hemp, in the manufacture of many coarse articles of extensive consumption hitherto woven of spun thread, and will furnish cheaper equivalents for baling and envelopes in general than any other kind of extracted fibres, or any other material that can be woven, netted, matted, or plaited, except dried, undressed, fibrous leaves. Indeed, they are here used instead of hair for sieves; instead of withes for baskets; instead of leather and wool for valises and trunks; and even curious substitutes for glass and clay, in the shape of bottles, bowls, cups, and saucers. Hence, I believe that, if introduced into the United States, the fibres of the *hennequin* would speedily be converted into a thousand forms of ornament and utility, all combining cheapness, strength, lightness, and durability." Mr. Dennis stated in the Report of the Patent Office of New York, in 1855, that in Florida there are thousands of acres of land, worthless for every other purpose, on which the Sisal hemp might be produced, and that the market value of it is placed beyond all doubt. A number of tons of it were collected and sent to market, where it readily brought within half a cent per pound as much as the best Manilla hemp—that is, about 250 dollars per ton, the produce of an acre. A coarser description of fibre, but one of great utility, is produced by the *Maguey*, one species of the Agave, which flourishes largely in Mexico, where the paper made from it is so much esteemed for its toughness and durability, that, in 1830, a law was passed in the Mexican Congress, enacting that no other kind of paper should be used in recording the laws or in the execution of legal documents.

The *Agave Americana*, which has been naturalized in the south of Europe, in the West Indies, and in Algeria,

rises to the height of 40 feet and upwards, and the fibres from its leaves,* though coarse and harsh, are said to produce the best coarse wrapping or envelope paper known. It is described as having "almost the toughness and tenacity of iron." The *Agave Vivipara*, which rises to the height of 30 feet as a pyramidal tree, and forms considerable forests, produces a good fibre, specimens of which, of admirable quality, were shown in the Great Exhibition of 1851.†

The BROMELIA or Pine-apple family, of which there are several varieties indigenous to the continent and islands of America, yields fibres varying in quality from the coarsest hemp to the finest flax, and are used for making thread, cordage, mats, bagging, hammocks, clothing, and paper. In 1857, Chief Justice Temple, of British Honduras, read a paper before the Society of Arts, on the *Bromelia Sylvestris*, or wild pine-apple, known as the *Istle* of Mexico, the *Pita Spiñuella* of Central America and Panama, and the *Bromelia Pinguin* or *Penguin* of the West Indies, and which ranks very high in economic importance. Its long, straight, and spiny leaves, from five to eight feet long, and from one and a half to three inches wide, are lined with a fine tough fibre, the *pita*, equal in strength and beauty, and in other respects better, than that of the hennequin. Lee exhibited a quantity of it, which he felt satisfied, and with good reason, might be rendered fit for use in the manufacture of every species of textile fabric. "I have been informed by leading manufacturers," he said, "that it is equal in texture to the best China grass, superior to the New Zealand flax, and capable of being manufactured into the finest substances." In like manner, Major Barnard, U.S.A., in his report on the Isthmus of Tehuantepec, says: "Of this prolific plant there are numerous varieties, all yielding fibres varying in quality from the coarsest hemp to the finest flax. It is indifferent to soil, climate, and season; and the simplicity of its cultivation and the facility of extracting and preparing its products, render it of universal use. From it is fabricated

* Mr. Bullock ("Six Months in Mexico") measured several of the leaves of this plant growing in Mexico, and found them 10 feet long, 15 inches wide, and 8 inches thick. The fibrous parts of the leaves are there made into strong twine or thread, as also into ropes for use in the mines.

† There were also specimens from various parts of India, Barbadoes, and Demerara. Dr. Hunter, of Madras, who sent some exceedingly interesting specimens of this and other fibrous materials, obtained a prize medal.

thread and cordage, mats, bagging, and clothing, and the hammocks in which the natives are born, repose, and die."

The *Bromelia ananas* also affords a fine foliaceous fibre. It has been introduced into the East Indies, where its fibre is extensively used in manufacturing the delicate fabric known to commerce as *piña*. It flourishes in Assam, and abounds on the Khasia hills, and in the vicinity of Rangoon, as well as in the Tenasserim provinces, and near to Singapore. Its fibres are very strong, and are as divisible as those of flax. Samples from Madras, Singapore, Travancore, and Java, were contributed to the International Exhibition of 1851. Some of that from Java was so fine that the jury awarded a prize medal for it to Mr. L. Weber.

The Musa or Plantain family ranks next to the *Agaves* and *Bromelias* for the quantity and value of its fibres; and Mr. Squier suggests that as the tree or plant, whether plantain or banana, is almost universally cut down when its fruit is gathered, many millions of plants now left to rot could be converted into articles of first utility for mankind, such as cordage, cloth, paper, &c., to which the Official Report of the Jury of the Great Exhibition of 1851 adds fustians, lawn, gauze, blonde lace, and candle-wicks, "if we had only proper machinery for extracting the fibre." The *Manilla hemp* is got from one of the varieties of the *musa*, and many other varieties, both of the banana and the plantain, contain fibre which might be turned to a profitable account, as a substitute for hemp, and as a material for paper. In 1854, Messrs. Smith, the eminent newspaper agents of London, offered a prize of £1000, for a cheap substitute for the cotton and linen material now used by paper-makers; and of the many papers sent in, that made from the fibre of the plantain came nearest meeting the requirements. It was admitted that the important condition of quantity of fibre could be met, provided proper machinery could be devised for its economic extraction, and that if prepared with skill, it would prove, in colour, and in every other respect, equal if not superior to the kinds of paper now in use. The plantain abounds in the East, as well as in the West, and produces fibre almost throughout. It is coarse and strong in the outer layers of the sheathing footstalks, fine and silky in the interior, and of a middling quality in the intermediate layers. Mr. Crauford is of opinion, as cited by

Dr. Royle, that the common plantain most probably afforded the Indian islanders the principal material for their clothing, in the same way that the indigenous species does in the Philippine Islands. The art of making cloth from its fibre was also known in Madagascar. I have myself prepared some of it for spinning, and can speak of it as a beautiful, even, fine, and flexible fibre, fit for almost anything.

Leaving out of view the fibre-bearing plants of the palm, lily, and screw-pine families, we cannot characterize the foliaceous fibres of the agaves, bromelias, and plantains in better, more truthful, or more concise language, says Mr. Squier, than in that of a man, who, before his sudden and melancholy death, had devoted many years of an active life to their study and utilization:—"Lighter, stronger, and more durable than the cortical fibres of hemp or flax, and produced by perennial self-propagation in stony, sandy, or swampy surfaces, with the easiest and cheapest cultivation, and the speediest and simplest preparation, the relative and positive prices and properties of the foliaceous fibres of the agaves and the plantain ensure their substitution for cortical fibres in the general consumption of mankind." *

The PALM family, including five or six varieties, produces fibres of different qualities; but the imperfect methods employed to obtain them leave most of them fit only for ropes, cordage, and coarse, rough, and harsh cloth. One variety of the *Palmetto* is, by the Arabs, mixed with camel hair for the cloth of their tents; and it is extensively used in France as *African hair*, in the manufacture of carpets, &c. The fibres, divested of the glutinous matters, are extremely divisible, and might be rendered as fine as flax.

The ASCLEPIA or Milkweed family, and some others, the different species of which amount to many hundreds, produces fibres which are found very useful for the manufacture of articles chiefly of a coarse description; although some of them, as the *Quimbombo* or *Molondron* of Cuba, known as *Okra* in America, yields a fibre applicable to the same uses as the flaxes of Europe.

Mr. Squier reproduces Don Ramon de la Sagra's list of plants suitable for cloth which are indigenous to Cuba,

* "Tropical Fibres," p. 16.

seventeen in number, and Seeman's description of the economical fibres of Panama, seven or eight in number; but whatever may be their capabilities—and of some they are considerable—the slow, laborious, and very imperfect modes of preparing them for use to which the people are confined, restrict their application (except in two or three cases in which a coarse cloth is produced from them for the natives) to the production of matting, ropes, rough sails for the canoes, cordage, &c. The processes are exceedingly primitive and slow, always leaving the fibre in some degree laden with matter, which, in proportion as it is there, deprives it of its usefulness, and sometimes—and not seldom—destroys a good deal of it in its progress.

Is it not surprising that more attention should not have been given than there has been to this immense supply of vegetable fibres, with the view of rendering them of greater value for manufacturing purposes, in both strength and fineness? As now prepared, they are left in a very imperfect condition, and most of them unfit for any but the coarsest use, and some of them for scarcely that. This is not to be wondered at, when the processes by which they are for the most part prepared are looked at. In Yucatan, the Sisal hemp is chiefly prepared by manually splitting open each leaf of the plant, and then rubbing and scraping each section until the pulpy and colouring matters are removed. They sometimes ferment the beaten leaves in water or mud; but that stains and weakens the fibre. The Manilla hemp of the Philippine Islands is obtained from the foot stalks of the plantain, by pounding them with clubs of hard wood, until the porous and gummy matters are said to be expelled, after which they are repeatedly passed through a coarse heckel. The New Zealand hemp is treated in much the same laborious and inefficient manner; and the consequence is, that the resinous matter left in the fibre renders it unfit for anything but the least valuable purposes. In Florida, where the *Agave Sisilana* has been introduced and is extensively cultivated, as also the *Agave Mexicana*, and the *Agave Americana*, or century plant, they have also introduced the rude process of Yucatan, of beating and scraping the leaves; or, after crushing them between a pair of rollers, steeping them in an alkaline pickle, which both weakens the fibres and destroys their silky gloss.

A great number of methods have been tried, some with

partial success, some with little or none, for dressing the fibres of these endogenous productions. Patents have been granted to Fenton, Hartig, and others, for preparing the fibre by boiling, or by means of dilute solutions of acids, alkalies, and ammonias. A machine for extracting the fibres from the leaves and stalks has been patented by Messrs. Sanford and Mallory, and was shown at the International Exhibition of 1862. It combines scraping and combing with washing, and is, beyond all doubt, a great improvement upon the present most rude processes of pounding with a mallet; beating with a club; scraping with a sharp stick, a blunted knife, an ox-bone, or a piece of hoop iron; sometimes burying in the earth, or pickling in alkalies; or other equally clumsy and comparatively ineffective expedients, by which a few pounds of fibre are obtained as the reward of a hard day's work. Mr. Squier thinks that the use of the machine will augment very largely the present supply of tropical fabrics, as it probably will; but it still leaves us with the fibres in a condition almost as far as ever from what is indispensable to their use in textile manufactures. No mechanical process, though accompanied by ever so much washing, will suffice to so far free the fibres from the tenacious matter which naturally binds them together, as to give them the requisite qualities for producing fine and soft fabrics. The manufacturers have still to look and wait for the great desideratum.

I may now leave the western continent, and look into the tropical regions of the eastern world, for their contributions towards that mass of fibrous material which is such a source of wealth and of usefulness to almost all the nations of the earth.

It is now more than sixty years since Dr. W. Roxburgh, then the Company's keeper of the Botanical Gardens at Calcutta, called attention to the fibrous vegetables of India, as furnishing an almost "unlimited" supply of textile material; and the experiments he made, and the samples he sent to Europe, were such as, it might have been thought, would long since have produced considerable results. We were contented, however, to go on relying upon our supplies of cotton from America, which continually increased with the demand—from 106,000 cwts. in 1814, to 4,600,000 cwts. in 1844, and 10,000,000 cwts. in 1860. The jury on "Animal and Vegetable Substances chiefly used in Manu-

factures, &c.," in the International Exhibition of 1851, revived the subject of Dr. Roxburgh's investigations and experiments, and referred to the strange neglect with which they had been treated. In their Report they say: "The old investigations of Dr. Roxburgh are of much importance; and it is remarkable that though the value of some of these Indian fibres was well known to him, and that he repeatedly sent samples of them to this country, they have never received that attention from practical men which they certainly deserved." The jury give a catalogue of about twenty of those fibrous plants which the doctor had experimented upon, with their comparative strength, remarking that it was "evident the experiments could not be regarded as other than very imperfect, having been conducted under unfavourable circumstances, and only going to prove that MANY OF THE FIBRES WERE VERY STRONG AND WELL MERITED FURTHER TRIALS."

This Report had the effect of again directing attention to the important subject; and in 1853 Dr. Forbes Royle, formerly superintendent of the East India Company's Botanic Gardens at Serampore, contributed a paper to the *Journal of the Society of Arts*, and in 1854 read a most informing lecture on "Indian Fibres; being a sequel to 'Observations on Indian Fibres fit for Textile Fabrics, or for Rope and Paper Making.'" This lecture excited so much attention, that it was not only printed in the *Society's Journal*, but was subsequently published as a pamphlet, which passed through several editions; and, after having been considerably enlarged by the addition of much valuable matter, it was republished in 1855, in an octavo volume of more than 400 pages. Dr. Royle was followed by Dr. J. Forbes Watson, "Reporter on the Products of India," who, in May, 1860, read a paper before the Society of Arts, in which he first "brought under notice those fibrous plants which, from practical considerations, seem worthy of immediate attention;" and then adverted to "our present wants as a manufacturing nation, and briefly indicated the more prominent points of interest connected with the supply of various raw textiles to this country."

In these works will be found a vast amount of information relative to the fibrous productions of our Indian empire, and of the capabilities of the soils and climates of that extensive region for their production; and no one who reads what is there written can fail to be struck with

amazement at the number and varieties of the fibrous plants which Nature has given us, and scarcely less at the apparent neglect with which they have been treated, notwithstanding the large demand there has for many years been for textile materials, above what have found their way into our markets. It is scarcely credible, but it is a fact, nevertheless, that "though India possesses so large a number of fibre-yielding plants, but few of them are objects of European commerce, or are known to the manufacturers of cordage or of textile fabrics in Europe."* This, as Dr. Royle remarks, is not because no efforts have been made to make them known, for in addition to the publications of Dr. Roxburgh† and the specimens of fibre he sent to England—where they were long exhibited—both the Directors of the East India Company and the Lords of the Privy Council for Trade and Foreign Plantations exerted themselves to bring them into notice and use.

My object in these few pages is not to describe the various fibre-producing productions of the East, but only again to call attention to them, as affording a vast and practically inexhaustible supply of an article we have a large demand for, and the use of which produces so many and great blessings.

Pretty well the only Indian fibres we know or use to any extent, are the Jute, the Sunn hemp, the Manilla hemp, and the China grass. Flax or hemp are both grown in Hindostan, but they are valued only for their secretions; the hemp for the intoxicating properties of its leaves; the flax for the oil stored up within its seeds. The stems of both, which in Europe are valued for their fibres, are in India generally thrown away or burnt. Within the last few years, however, efforts have been made to cultivate flax in the Punjab for the sake of the fibre. Nevertheless, India produces, as we might infer from its vast extent and its diversified soil and climate, every variety of fibre, and that in immense quantities.

By some it has been said, observes Dr. Royle,‡ that if

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* Royle—"Fibrous Plants of India," p. 6.

† Dr. Roxburgh's letters and reports, originally published in the transactions of the Society of Arts, were, after his death, collected, and, with some other contributions of his pen, published in a volume entitled "Observations, &c., on the various Specimens of Fibrous Vegetables, the Produce of India, which may prove valuable Substitutes for Hemp and Flax on some future day in India."

‡ "Fibrous Plants of India," p. 11.

these Indian fibres possess any useful properties, or can be afforded at reasonable rates, and there is any demand for them, they will be sure to find their way to market. But there is always more or less difficulty in introducing new things as materials for manufacture. Prejudice, private interest, and, in many cases, a mere desire to escape from additional trouble, all stand in the way. Nearly a century ago, Lady Moira, by the aid of Mr. Bailey, of Hope, near Manchester, converted refuse flax and hemp into cotton, which could have been sold at threepence per pound. The jurors of Class IV. in the International Exhibition of 1851, thus notice the fate of Lady Moira's scheme:—

"She says—'I have no reason to be vain of the samples I sent you, they merely show that the material of flax cotton, in able hands, will bear manufacturing, though it is my ill fortune to have it discredited by the artisans who work for me. I had in Dublin, with great difficulty, a gown wove for myself, and three waistcoats; but had not the person who employed a weaver for me particularly wished to oblige me, I could not have got it accomplished; and the getting spun of an ounce of this cotton in Dublin I found impracticable. The absurd alarm that it might injure the trade of foreign cotton, had gained ground, and the spinners, for what reason I cannot comprehend, declared themselves such bitter enemies to my scheme, that they would not spin for me. Such is my fate, that what between party in the metropolis and indolence in this place (Ballynahinch), I am not capable of doing my scheme justice. Though long accustomed to behold shoes and stockings looked upon in this part of the world, by the generality, as quite unnecessary, yet I cannot but think that some apparel is requisite; and as the price of wool is so high, and the poverty of the people so great, I did wish to introduce among them that invention which I saw might be greatly improved, and turn the refuse of flax into comfortable clothing, and by a process so easy that every industrious wife inclined might prepare it.'"

Lady Moira states that the flax-cotton gowns which she had had made, and which were worn by the members of her own family, were exceedingly durable; and the specimens of these fabrics, as well as of the flax-cotton prepared by her, which are still preserved in the Museum of the Society of Arts, are referred to by the jury, as "highly remarkable for their beauty."

Following Lady Moira's praiseworthy efforts, and, to some extent, successful experiment, were the experiments of Baron Meidinger, of Vienna, and those of Kreutzer, Stadler, Haupfner, and some others; but they all failed, as the jury think, from the effects of jealousy and opposition, as in the case of Lady Moira; and to show the probability of this being the cause of the failure, they quote Beckmann, who speaks of the manufacture of flax-cotton near Brunswick, and states that the work-people determined not to use it, though excellent fustians were made, which could not be distinguished from those manufactured with ordinary cotton.

I am not able to determine with what degree of justice the failure of these experiments is wholly attributed to the opposition of the manufacturers. Just as some of the English paper-makers are and have for some time past been crying for "Rags!"—"Nothing but rags!"—"Rags, and no surrender!" So, probably, the cotton lords would have nothing but cotton—"Cotton, and no substitute." But it should be observed, at the same time that we notice this imputation upon them, that, though Lady Moira succeeded in getting as much of her flax-cotton spun and woven as sufficed to make two or three gowns, which were "exceedingly durable," and the Germans, after great difficulty, produced some "excellent fustians not to be distinguished from those made with ordinary cotton," the probability is, that there really was something in the manufacture of the material which rendered it much less adapted for spinning than the cotton fibre itself. Lady Moira used flax-waste, but I do not know how either she or the German experimentalists obtained the fibres of the proper length to be used as cotton. In the more recent experiment of Claussen, to whom the jury of Class IV., in the Exhibition of 1851, awarded a prize medal, for an "ingenious process," which they thought likely to "lead to several new and important practical applications," the fibre was cut into the required lengths, which would, in itself, have been sufficient to prevent its coming into general use for textile manufactures, inasmuch as the fibres, thus cut at the ends, are deprived of the quality which gives to cotton its capability of uniting fibre to fibre, without producing an uneven surface. Cut fibres necessarily lack that power of uniting themselves one to another, so as to form a lengthened thread, which is one of the most important qualities

of cotton. Subsequent successful experiments for adapting fibrous materials for the spinner's use, however, indicate the existence of that repugnance to the introduction of new staples, to which the failure of Lady Moira's production, and that of others, has been attributed.

As lately as 1839, a lady named Davy, produced specimens of a thread prepared from the wild pine-apple plant of Assam, of various degrees of fineness, and subsequently sent cloth made from it to the Agricultural Society of Calcutta, stating that she had experienced much difficulty in getting it woven, as the principal manufacturers in Decca positively refused to make it into cloth, and that it was ultimately woven by a man in the jungles, near Decca. Professor E. Solly showed specimens of the fibre to spinners in this country, but, like the cotton-spinners before them, they did not think it would do as a substitute for flax. Mr. Zincke, however, took out a patent for the manufacture of the thread, believing, from its beautiful silky lustre, combined with considerable strength, that it was well adapted for the making of good linen.

I have myself cottonized various Indian fibres, and produced many specimens of all degrees of fineness, length, and colour, fit in every way to be used by themselves, or to be mixed with other materials. No objection can be taken to the fibre. It is fine, even, strong, and uncut. It has been examined by practical men in England, France, Holland, Belgium, and America, and has been by them pronounced to be equal to any cotton produced in the Southern States of America. The French and the Americans have both invited me to impart to them the means of thus obtaining from vegetable substances that are to be had in practically unlimited quantities, and now possess little or no commercial value, a fibre which will completely answer all the purposes of cotton, and that is in all respects suited to the existing cotton machinery; but the English manufacturers have hitherto exhibited no disposition to try it.

Whatever may be the cause, it is certain that the fibres of India—though so many in number, and possessing, as some of them do, the greatest strength and a capability of being divisible to any extent of fineness, and therefore fit for any textile purpose—have been almost universally neglected by Europeans. If to their quality we add, that most of them are easily cultivated, and can be brought to the

markets of Europe, even from those distant fields, so as to contend in price, even in ordinary times, with the favoured produce of the nearest countries,* we must, as I have already observed, be greatly struck with the circumstance of their neglect. "In the Moorva, the Aloe, and the Agave, as also in the Pine-Apple, and, above all, in the Plantain," observes the author just referred to, "we have found supplies of material, not only for paper-making, but for the finest as well as the coarsest textile fabrics, and for cordage, which may rival Manilla hemp, or the American Agave, which bridges over broad rivers. The oakum of these plants may be converted into paper; and that made from the plantain is remarkable as well for fineness as for toughness. The fibres may be woven into fabrics of different qualities, and though they may not be well fitted for making knots, they may yet be twisted into ropes which are capable of bearing considerable strains, and possess the advantage, in their white colour, of not being likely to deceive the purchaser by a resemblance to hemp. . . . . Among the malvaceous and leguminous plants, or those among which the Brown Hemp, the Dhunchee, and the Sunn of India are found, with the Jute among the Linden tribe, we have a variety of cheap products, because the plants can be grown with ease, and their fibres be separated with facility. The supply may, moreover, be indefinitely and rapidly expanded, because they form a part of the ordinary culture.

"But, if we require fibres possessed of all, or even of more than the strength of Russian or of Polish hemp, we shall find this a property, not only of the hemp of the Himalayas, but of the various nettles which clothe the foot of these mountains, from Assam to the Sutlej; and, if we pay a price proportioned to the quality of the article, I have no fears but that the supply will increase in proportion to the demand. If we want them still cheaper than they can at present be furnished, we have only to supply the cultivators with some simple machinery, by which the fibre may be separated more easily than by the present primitive methods. In that case, I feel assured that the Rheea fibre will not only undersell every other fibre, but, in point of strength, take a position which will be second to none of those which are at present imported. India is in many

* *Vide* Royle, "Fibrous Plants of India," p. 6.

respects so well suited to the growth of fibres, that the supply, not only of this, but of many others, may easily become more abundant than from any other country."*

Thus, we see that both continents present, for our acceptance and use, a profusion of vegetable substances, most of them capable of being rendered highly useful, and so various in their qualities as to furnish materials for almost every species of manufacture, in which strength, durability, and flexibility are required, from the stoutest rope and canvas, to the finest and most delicate tissue. Some of them have been appropriated in various ways to the use of mankind, for many ages past; but their value, so far as I can judge, has never yet been fully ascertained, in any part of the world.

Even the coarse fibres of the tropics are capable, by a proper course of treatment, of far greater usefulness than they have hitherto yielded; while scores of varieties of a finer description, now scarcely usable for any textile purpose, possess qualities which, if they were properly freed from the resinous substances by which they are, more or less, laden, are available for being wrought up into fabrics quite equal to the costliest productions of the loom. Take the Manilla hemp, for example, produced by one of the varieties of the Plantain family, and see what are its qualities and uses, as we obtain it at present. It is strong and durable, but brittle and hard, and not well adapted, therefore, for textile purposes. But this is not attributable to any inherent defect in the fibre itself, which may be obtained in a beautiful condition of fineness, flexibility, and strength. I have experimented on it in sufficient quantities to place it beyond doubt, that, as a fibre for weaving alone, or for mixing with silk in the loom, it is adapted to produce a very fine, enduring, and cheap fabric—altogether unlike the jute now so extensively used up with other materials, which present an article fair enough to the eye, but of extremely little value in use.

The same thing may be said of many of the other fibres obtained from the vegetables of the tropics, in both hemispheres, usable now only for a few coarse purposes by the natives of the countries which produce them, after being

* "Fibrous Plants of India," p. 376. The Rheea fibre and the Japan hemp are now coming into extensive use for tying up flowers, &c. They may be put to much better uses.

put through the same rude and ineffective processes as were employed many years ago.

There are, no doubt, some fibres that are naturally coarse and uneven, and are possessed of other qualities that unfit them for delicate or even for moderately fine textile uses; but many of these may be put through a process, which, while it is simple, expeditious, and inexpensive, will adapt them to a variety of important uses, in the form of cheap cloth, possessed of great durability; while, of the remainder, almost all may be easily brought into a condition admirably fitted for the manufacture of paper, of various kinds—much more so, indeed, than the Spanish *esparto*, now coming into considerable demand as a material for that manufacture. Not that *esparto* is naturally ill adapted to produce paper of a fine texture and of the necessary strength, but the only methods of preparing it hitherto known, leave it in a condition which makes it anything but desirable to the consumers of the paper into the composition of which it is introduced. For the manufacture of paper, there is, in fact, no want of material in every way adapted for it; and the paper-makers of the United Kingdom would soon find it to their interest to turn their attention to some of it, instead of spending their time in futile attempts to induce foreign countries to supply them with rags, at a price which will enable them still more successfully to compete in the paper-markets of the world. In the United Kingdom itself there are many fibrous vegetables, either growing spontaneously, and as a detriment to the cultivators of the soil, or which may be grown on land now of little value, from which a cheap and beautiful stuff for the manufacture of paper may be made. We shall get wiser, it is to be hoped, by-and-by, and pick up some of the things that lie under our feet, instead of looking after them in places whence we are not likely to procure them, or proposing, in our great wisdom, to convert a high-priced material into a cheaper one, at the cost of a good deal of labour and expense, and failing after all in the experiment. Who could have imagined, beforehand, that a jury, composed of professors, councillors, and *savans*, all of reputation for their knowledge of art and science, would award a prize medal for making flax-cotton;—that is, as they say, for so "dividing and splitting up the flax fibre as to convert it into a substance very nearly resembling cotton"? Under any circumstances that now exist, and are likely to exist for

a long time to come, flax must always be a dearer material than cotton, and it is difficult to see the wisdom of so dividing and splitting it up as to make it resemble cotton. It was all very well for Lady Moira, who desired to see the poor Irish wearing stockings, to convert waste flax into "a substance very nearly resembling cotton;" but that flax should be grown for any such purpose, especially when material at present next to worthless, and better adapted than flax for conversion into a substance resembling cotton, may be had in abundance, is one of the noticeable things which occasionally arrest one's attention. And it is now being done. I have already stated that America had evinced a desire to possess itself of the means of manufacturing a material to be used as cotton, in the absence of those supplies of the true cotton they formerly had from the now rebel states. My specimens of cottonized fibres had satisfied them of the practicability of producing a substitute for the genuine article, and the Rhode Island Agricultural Society, upon finding that I was not disposed to accept an invitation to go over to New York, and impart the method of doing it, took up the notion of Claussen, and resolved to get cotton out of flax, as appears from the following paragraph I have copied from a New York journal:—

Flax-Cotton.—The Rhode Island Agricultural Society has sent to Washington a memorial to be laid before Congress, asking for an appropriation to enable the society to prosecute its experiments in the manufacture of flax-cotton. Those who have given most attention to the subject are confident that the difficulties in the way of manufacturing flax can be overcome, and that with such facilities as the appropriation they desire would furnish, some of our ingenious men would soon accomplish the object which has been so long sought.

I do not know whether the appropriation asked for was granted, but the Society seems to have gone forward with its project, though, as yet, without any result, if we may judge by the following paragraph from the *New York Herald*, which I take from the *Daily News*, of July, 22nd inst.:—

Flax Culture.—More ground has been put under flax cultivation than for many years, but hardly enough to exercise any perceptible influence on the price of cotton. The great and essential difference between the fibre of flax and cotton is, that the former contains a large quantity of gum, which we are unable to extract by any steeping process now in use. This excess of

gummy matter presents a serious obstacle to sliding or drawing the fibre, which is the basis of all spinning operations. When a process shall be discovered by which the gum can be entirely removed from the fibre, flax will be spun as readily and as fine as cotton.

It is quite clear that the writer of this paragraph does not understand the whole "difference between the fibre of flax and cotton;" and it is quite clear, also, that the Americans are not more advanced than the rest of the world in the possession, of means for "entirely removing the gum from the fibre," which they conceive to be the only thing that stands in the way of accomplishing their desired object. They are on the wrong scent, however. Flax is not the material they want; but something much cheaper and more in abundance;—and both these conditions are satisfied in the fibrous productions of India.

There is, in truth, no assignable limit to the variety of fibre, for every useful purpose, that may be readily obtained in India; but to obtain the full benefit of these productions of Nature, and especially to confer upon the natives of India, as WE should do, a share of it, efforts must be made to introduce such processes for obtaining the fibre from the various plants which produce it as will at once give the people employment, and improve the quality of the material. If I may be permitted to say so, England, my adopted country, has a very responsible charge committed to her in her Indian Empire; and there is good reason to believe that one of the most urgent conditions for ensuring permanent tranquillity and prosperity amongst the native population, is that of giving them remunerative industrial employment, for which the means are neither scant nor difficult to be laid hold upon.

When the attention of statesmen shall be earnestly given to this important subject, the conversion of now wholly or nearly useless vegetable substances into valuable materials for manufacturing purposes will not fail to present itself among the first that may be promoted with benefit not only to India but to the world at large.

It is, as I have previously stated, sixty years since Dr. W. Roxburgh called the attention of Europe to the fibrous products of India, and described and sent specimens to England of about twenty different species which he had by experiment found to be of a valuable description for economic purposes, some of them being capable, by better

modes of treatment than he had been able to adopt, of being used for textile purposes of a very superior description.

The specimens that were exhibited, of both raw fibres and manufactured articles, at the International Exhibition of 1851, showed how little we had done towards appropriating to the uses for which they are so well adapted, even those fibres which had so many years previously been pressed upon our attention, to say nothing of the numerous varieties that may be so readily added to them. India appears to me to be pre-eminently a country for fibres, said Dr. Royle, in 1856,* and because I believe that a great mass of valuable material, which now yearly runs to waste, may more readily than almost anything else be turned to profitable account, my attention has been directed to these fibrous substances. In the first place, the vegetation of the country is characterized by a teeming abundance in species of plants known to abound in fibres. Thus, without enumerating the gigantic grasses, the *plaintain* and the *marool* yield large quantities of white fibres. Among the palms, in addition to cocoa-nut fibre, we have the black *Ejoo* fibre, remarkable as well for strength as for incorruptibility when exposed to wet. As the lime-tree yields Russian bast, so the Jute and its congeners of the same family are now equally indispensable to our manufactures. As the leguminous and malvaceous classes of plants include several groups, of which numerous species abound in fibres, so do also the *Asclepiads* and the *nettles;* combining to afford us any variety of fineness and of strength which we can expect, or I may almost say wish for, in fibres. The climate, moreover, is favourable for the growth of these fibre-yielding plants; for, as most of those to which I have to allude, belong to the indigenous flora of India, their period of growth is during the rainy season, when there is suitable heat and abundant moisture. Thus is secured the rapid growth of the parts of vegetation, in which almost entirely these fibres abound. As the rainy season comes to an end after three, or, in some parts, four months, there is usually fine weather for the separation and preparation of the fibres. There is, moreover, great abundance of unoccupied land, as well as of cheap labour, and easy acces-

* "Journal of the Society of Arts," vol. 5, p. 17.

sibility, either by sea or river carriage, to the places where the fibres chiefly are found.

Well, then, with such a superabundant quantity of materials to draw from, what do we appear to have done up to the year of the first great International Exhibition, 1851? Under the circumstances stated, and the multiform uses to which we could put fibrous material, the specimens exhibited were miserably few; and the few showed how little we had done in order to make the best of them. There were samples of—

"The *Calooee* of Sumatra, or the *Rhea* of Assam, which Dr. Roxburgh named the *Urtica tenacissima*, known in commerce as China grass, and which, with other varieties of the *Urtica*, is abundant in many parts of India, and may be had in almost unlimited quantities. The fibre is very strong, fine, and has a brilliant silky appearance. There were specimens of it from Calcutta, Assam, Rungpore, Singapore, and China, but they afforded no reason for believing that any material improvement had been made in the methods of preparing them for textile purposes. In 1814, the Society of Arts awarded a silver medal to Captain Joseph Cotton, of the East India Company, for its introduction here, where its value as a material for manufacture was tested by competent persons. The chief obstacle which interfered with its use, say the jury on raw materials used in manufacture,* was the difficulty which was found to exist in the preparation of the fibre from the stems of the plants. None of the processes usually adopted with flax or hemp were found to be at all suitable to it; and the rude, wasteful, and imperfect means employed by the natives in preparing it for the manufacture of twine, thread, and fishing-nets, by the mere process of scraping, were wholly inapplicable on a large scale, and gave besides only a very inferior result. When macerated or wetted in water, it was found that the fibre itself was more easily destroyed than the glutinous matter of the stem; and, during the last forty years, various attempts have been made to devise a good and cheap process for preparing it, but hitherto without much success. It was hoped that the mechanical process of Mr. James Lee, introduced many years since, would have answered the purpose; but it failed to do so, as did also the rival invention of Messrs. Hill and Bundy;

* Report, International Exhibition, 1851, p. 100.

but the jury to which we have referred, expressed a conviction, that the process of Messrs. L. W. Wright and Co., for which they obtained a patent in 1849, would succeed.

It is worth while to describe this process, in order to show how far it is from rendering it probable that the China grass will, in consequence of the introduction of this method of treating it, ever become a largely consumed material in the production of woven fabrics, for which it possesses such fine qualities. Messrs. Wright's process consists in an "ingenious" boiling of the stems in an alkaline solution, after they have been previously steeped for twenty-fours hours in cold water, and for twenty-four hours in water at a temperature of 90°. The fibre is then thoroughly washed with pure water, and finally subjected to the action of a current of high-pressure steam, till nearly dry.

It may be very safely predicted, that, beautiful as this fibre is in its appearance, and admirable as are its qualities, it will not be brought into general use until a much more simple and readily available process for preparing it is adopted.

There were samples of *Paat* or *Jute*, the produce of various species of the *Corchorus*, from Calcutta, Madras, Rungpore, and other parts of India; and, notwithstanding the unevenness of the fibres, and their harshness and want of strength, this material has, since the stoppage of our supplies of cotton from America, become an article of considerable use, for mixing with silk, cotton, wool, and other articles. Our consumption of it has been more than quadrupled in ten years. Our imports from India were—

1853	275,578 cwts.
1863	1,223,033 cwts.

The computed real value of the imports of the last-mentioned year was £1,525,996.

Jute now forms an important material in the manufacturing industry of Scotland, where it is used in making brown cloth, sacking, packing-cloth, and carpets, for the latter of which it is said to be well adapted. The number of spindles acting on jute, in Dundee, was stated, in 1862, to be as many as from 35,000 to 37,000; and the consumption of the material was said to reach 20,000 tons annually, at a price varying from 2½*d.* to 5*d.* per

pound.* With proper treatment, it is a fibre of a very beautiful silken texture, and is of great strength, working in a most satisfactory manner with almost any other textile material.

Of *Marool, Moorva*, or bow-string hemp, as it was named by Dr. Roxburgh, there were some samples, which showed how much might be done with it under good management. It is from a plant (*Sanseviera Zeylanica*) which grows wild under bushes in the jungle, and is very abundant. Dr. Roxburgh thinks the Chinese grass, used by the Chinese for fiddle-strings, fine fishing-nets, &c., is nothing else than this plant. He called it *bow-string*, because it is used by the natives of the Circars for the purpose of stringing their bows.

The *Agave* or Aloe family furnished various contributions from many parts of India, and from Barbadoes, Trinidad, Madeira, and the Cape of Good Hope. I have, in a preceding page (24), spoken of two or three varieties of this family, and of the uses to which they are put in some parts of the Western world. They are not less useful in the East. A very interesting series of the fibres, obtained from the large Hill aloe, and from the small aloe, illustrating the preparation of the fibre, exhibiting some of the uses to which it is applicable, and showing the facility with which it may be dyed of various colours, was contributed by Dr. Hunter, of Madras.

The *Sunn, Janapam,* or Indian hemp, from the *Crotolaria Juncea*, which approaches hemp in the manner of its growth and cultivation, and is in general use in the hotter parts of India, was also exhibited. It is so easy of culture and so productive, that the East India Company, many years ago, made considerable efforts to convert it into a lucrative article of commerce. In like manner with all the other fibres, however, it has been greatly restricted in its use, for want of better methods of preparing it.

Yercum Nar, the fibre of the *Calotropis* (*Asclepias*) *gigantea*, is one of the most common jungle plants of India, and produces a fibre used by the natives of the Bengal and Madras Presidencies in the manufacture

* The following statement of the arrivals, direct and indirect, at Dundee, for the six months ending June 30, 1860 to 1864, shows the progressive increase in the manufacture of this fibre:—

1860.	1861.	1862.	1863.	1864.
18,785 tons.	18,457 tons.	19,568 tons.	25,327 tons.	34,213 tons.

of cord, called "Lamb-dore," or "Toondee coir." It flourishes in any and all soils, and requires neither culture nor irrigation. The experiments made by Dr. Wright proved the fibre to be first, in point of strength, of all the Indian fibres tested, its breaking weight being 552 lbs., while that of cotton was only 346 lbs. Dr. Forbes Watson observes, that, although the finest fabrics can be made of it, the method hitherto employed for obtaining it from the flesh-plant is so tedious and unproductive that it is not likely to come into general use. Dr. Hunter tried steeping, but he found that the dissolved juices, which are of a very acrid description, act upon the fibres, and injure them. The fibre used to be employed by the wealthy natives of India for making strong cloths, cambrics, and lawns, worn by the Rajahs. It has been employed by Messrs. Thresher and Glennie for the manufacture of a substitute for flannel and other fabrics. It is known in commerce as mudar silk-cotton.

I should much like to try some of this common and hardy plant, and have very little doubt of obtaining from it a fine and very useful fibre, which might take the rank for which it seems to be designed.

Musta Paat, from the *Hibiscus cannabinus*, hemp-leaved hibiscus, is common all over India, and is cultivated in many parts for its fibre; but it is very little known in commerce, in consequence of the imperfect condition in which the method of preparation leaves it. The plant is steeped until putrefaction commences, and, after being washed, it is beaten until the fibre is separated from the wood. Ten years ago, Dr. Royle truly observed that the beautiful and silken fibres of the hibiscus seemed much too valuable to be any longer neglected. But, alas!

Plantain fibre, Manilla hemp, ejoo or gommuttee palm, yucca, dhuncha, and a few other fibres were also exhibited, but only to augment our regret at finding materials which possess natural properties that fit them for fine and important textile purposes, chiefly confined, by our defective methods of treating them, to the manufacture of cordage, twine, ropes, mats, and coarse rough cloth. This is especially mortifying, too, inasmuch as it has been stated, upon undoubted authority,* that "the Government has given

* Dr. Forbes Watson. "Journal of the Society of Arts," vol. 8, p. 481.

abundant evidence of its anxiety to aid in the good work, the various experiments which it has, at one time or other, instituted, having cost hundreds of thousands of pounds. . . . The hitherto practically insurmountable transit difficulties are in course of rapid removal, and the Government is, on every occasion, manifesting the utmost anxiety to give attention and countenance to every feasible scheme, and there is no doubt, that, should those in this country more directly interested in increased production come forward, with the view of *aiding themselves* in this matter, every legitimate encouragement will be warmly afforded on the part of the Indian Government, as well as of the officials, who practically are the governors of our various Indian districts, and on whose countenance and support much undoubtedly depends."

I may notice here, that Mr. Ferdinand Mueller, the Government botanist, has recently called attention to the indigenous fibres of Australia fitted for manufactures, and it is greatly to be desired that they may receive that attention which they undoubtedly deserve. Among those that can, no doubt, be rendered available for textile purposes may be noticed the *Phormium tenax*, or New Zealand flax, of which there are two varieties that might be made to supply the wanting material to British weavers, if only the genius of invention, as Mr. Mueller observes, succeeds in overcoming "the hitherto experienced difficulty of separating, by an easy method, without sacrifice of the material's strength, the fibre from the leaves"—an achievement which, I am happy to say, has been accomplished, as any one may see by inspecting samples which I have prepared by a cheap and easy process.

The fibre of the less prolific *Doryanthea excelsa*, or giant lily, of New South Wales, greatly resembles that of the *Phormium tenax*.

Mr. Mueller enumerates several other Australian plants which are employed by the natives for making nets, fishing-lines, cordage, &c., and which grow in abundance on the banks of the Murray, and in several other parts of the Australian continent. Hitherto little attention has been given to them in Europe, although there is no reason to doubt that they possess properties that would adapt them, under proper treatment, to very useful purposes. The useful fibrous properties of the *Lepidosperma gladiatum*,

and another plant, the *Lavatera plebeja*, were brought into notice by Mr. Alexander Tolmer, of South Australia, who sent a quantity to England, where it was made into a good paper. The *Lepidosperma* is very prolific throughout South Australia, Victoria, and New South Wales; and all that is wanting to bring it into extensive use is a cheap and efficient method of detaching the fibre from the flesh of the plant.

We patiently awaited the Exhibition of 1862, hoping, that, after all that had been said as to the want of better methods of treating these fibres, and of the great increase in their consumption that would necessarily follow such methods, much progress would have been made towards their introduction, if they had not, indeed, been carried on to perfection, in the course of the eleven years—1851 to 1862. But any one who visited the Exhibition in the last-mentioned year, with such an expectation, would have been bitterly disappointed. Indian fibres were there, in abundance; but they were almost exclusively contributed direct from India or from the collections of the India Board, selected and arranged by Dr. Forbes Watson, according to their ascertained strength and other qualities. There was also a set of eighteen books, containing working specimens of all the principal textile manufactures of India. Very few specimens were sent by any persons resident in this country, who had rendered the fibres more fitted for weaving into cloth than they had been left by the rough and tedious methods of treating them adopted by the natives. Upon the whole, one cannot help seeing, that, greatly as we have stood in need of fine fibres for some years past, very little progress has been made in discovering methods of treating those obtainable from India and elsewhere—including many of the English and of the French colonies—so as to give them that manufacturing and commercial value of which they are susceptible.

The supply of fibres, from all sources, is far from meeting the demand for them, not only for clothing, but for many other purposes, of which the manufacture of paper is one. Whence is the deficiency to be supplied? is, as Mr. Squier remarks,* a question which is more frequently and earnestly repeated with every succeeding year, and to

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* "Tropical Fibres," p 10.

which no satisfactory answer has yet been obtained. It is true, as he observes, that naturalists, without exception, have always pointed to the tropics, with its numerous and exhaustless varieties of plants, producing foliaceous fibres, as capable, not only of supplying all existing or possible deficiencies, but as capable also of furnishing new and beautiful, as well as cheap, materials, for new and useful manufactures. But the quantity thence obtained, up to this time, has been insignificant, considering the practically illimitable sources of supply; and the deficiency has resulted—as is on all hands admitted—from a lack of efficient and economical methods of separating the fibres from the pulpy and woody materials and the salts and gums with which they are mixed in their natural state.

III.—DESIDERATA FOR FIBRES.

I have, in a preceding part of this memoir, spoken of the difficulty generally experienced in introducing new materials into the manufacturing world. I should, perhaps, have added another reason for this to those I have there adverted to—namely, the doubt that is often and not unreasonably entertained as to the possibility of obtaining continuous supplies of new materials, under such conditions as would render them available for the purposes proposed.

When one looks back upon the manifold methods of procuring fibre for textile manufactures that have been brought forward during the last twenty-five years, and almost immediately abandoned, it is impossible not to feel that manufacturers have some reason for the scepticism with which they treat every fresh appeal to their judgment by the claimant of some new process. This certainly stands a good deal in the way of progress, and it is very desirable that something should be done that may tend not only to encourage science in making its experiments, but to assure manufacturers that the results are really such as they are represented to be.

This is more particularly the case with reference to those foliaceous and cortical fibres which I have been noticing than with any other manufacturing material. The quality of cottons, wools, silks, woods, metals, gums, oils, &c., are pretty much as they are produced by Nature.

But it is otherwise with fibres. These must be handed over to the manufacturer, not as Nature has given them to us, but divested of important adjuncts which belong to them in their natural state; and their utility as articles of manufacture is in proportion as they are freed from these, without sustaining injury in the process. The extent to which this is effected in any particular case cannot always be determined at once. It may be necessary to pass the material through various stages of manufacture, and then to subject it to still further tests, requiring time and involving expense, before it can be fully determined. In the meanwhile, the poor operator may be exhausted of his means, and become incapable of completing his discovery, or at least of demonstrating its value to those who alone can give it effect. Many obstacles may, in fact, stand between him and the completion of his object, though he has really discovered the means of effecting it; or he may have fully completed it, but be left without the means of showing that he has done so.

A good deal may be effected towards removing some of these difficulties, by ensuring full publicity for what has been from time to time accomplished, and a fair examination of it by competent judges; and still further, by exhibiting, under the best possible circumstances, the progress that has been made in any particular direction, and the steps by which it has been reached, accompanied by such particulars as would leave nothing to be desired as to the certainty of producing the article in such quantities and at such prices as would meet the wants of the market; with all other particulars that might be required by those who could turn the material to good account.

Dr. Royle, whose work on the fibrous plants of India I have already referred to, suggests the desirability of Trade Museums, in order to dispel the ignorance which prevails respecting many valuable natural products, and as a most likely means to ascertain the real commercial value of many products now almost, if not quite neglected;* and a remark of his, elsewhere, may be thought to have a direct bearing on the same subject. He says—"The difficulty in making new things known and appreciated, as articles of commerce, arises chiefly from the habitual neglect of such things when sent for inquiry from abroad, in order to have

* "Fibrous Plants of India," p. 9.

their value ascertained at home. For, if sent as specimens, I have seen many reports, in which they are pronounced to be of 'no value,' because they are 'unknown in the market.' . . . . The article is sold with other colonial produce, with little or no information respecting its properties, or the quantities in which, and the prices at which it could be supplied, if it should be approved of. Indeed, I am informed," he says, "that the novelty of the appearance, or the strangeness of the name, is more often the subject of jest, than the article is one of serious inquiry."*

Professor Solly speaks to the same effect:—"A new substance, like a new process, is looked on with distrust. It 'is not in the market;' the broker does not know it, and that is nearly the same as pronouncing it of no value: it is put up to auction, sold for a ninth part of its value, and what becomes of it is a mere chance. Sometimes it falls into the hands of clever and enterprising men, a demand for it rapidly arises, and it is then afterwards brought to market; but more frequently it is thrown aside as useless, because no pains are taken to apply it in the right manner, and in a couple of years it is altogether forgotten." †

Dr. Forbes Watson says, the Government entertains a strong desire that "every product grown in India should be as well known in this country as flax itself." And he expresses his belief, that "the day is not very far distant when this will be accomplished, and these products, which are of so much interest, be placed in different museums throughout the country, with the fullest opportunities for their inspection by those interested in them." ‡

There is, no doubt, a good deal of truth in what is here said about one kind of difficulty that interposes itself between the possessor of a new material and the manufacturer, who alone can introduce it into use; and with regard to fibres, especially those from tropical countries, it is probable that something towards its removal might be effected, by bringing them under further notice in trade museums. I do not think, however, that trade museums will ever supply all that is wanted to give an impetus to the treatment and consumption of these valuable materials.

If fibres were exhibited thus extensively with other

* "Fibrous Plants of India," p. 12.

† "Lectures on the Results of the Great Exhibition of 1851," p. 251.

‡ "Journal of the Society of Arts," vol. viii., p. 513.

objects, in trade museums, there is no question that many persons would be induced to look at and admire them, as they now do in the museums in which fibres find a place. But they are noticed only in common with other objects of novelty and attractiveness. The attention is too much distracted by the numerous articles that are presented to it for any one particular object, unless there be something almost marvellous about it, to secure the observation and excite the inquiry it is desirable to ensure for these fibres. I would say, then, by all means let the fibrous products of Nature, as well as all other products which are or may be rendered useful to man, be exhibited in trade museums throughout the country. But it is desirable to have, in addition to these exhibitions, something that shall invite special attention to so rich a legacy of Nature as the fibres of both hemispheres constitute; and that shall tend also to stimulate scientific men to further improvements in their treatment, by exhibiting the results that have been already obtained, marking them as they have gone on, step by step. As a merely interesting exhibition for sight-seers, a Museum of useful fibres—in which should be arranged every known variety, in every stage of progress, from the vegetable in its natural state to its conversion into various articles of manufacture, and showing the raw material as prepared by the earliest and rudest methods, with the successive improvements made in them, down to the latest and most efficient methods known—could not fail to be of a very attractive character.

But the utility, also, of such a museum would, I believe, be very great. One or two facts I have stated sufficiently indicate the value to the United Kingdom of the fibrous substances already brought into use, to enable any one to form some notion of the benefits to be derived from such an increase in their quantities as skill and science may undoubtedly put us in possession of. But the fact will be more thoroughly seen, and be made more impressive, by the following statement of textile materials imported from our own possessions and from foreign countries, which I have compiled from the Statistical Abstract of the United Kingdom, from 1849 to 1863, as laid before Parliament, by command of Her Majesty.

Materials.	Quantities.		Average Prices.		Gross Real Value.	
	1860. Cwts.	1863. Cwts.	1860. £ s. d.	1862. £ s. d.	1860. £	1863. £
Cotton, raw.....	12,419,096	5,978,422	3 1 5	7 17 7	35,756,889	56,277,953
Flax	1,464,810	1,458,902	2 11 9	2 15 7	3,830,770	4,271,059
Hemp and other like substances.....	768,033	1,067,913	1 0 2	1 5 1	1,147,193	1,811,867
Jute.....	816,787	1,223,033	0 16 2	0 19 4	660,913	1,525,996
Rags and other materials for paper	323,100	908,960	. . .	. . .	323,044	592,214
Total.....	15,791,826	10,637,270	. . .	. . .	41,724,809	64,479,089

These figures show not only the enormous use we make of foreign vegetable fibres, and the large amount of our industrial employments which they furnish; but, in addition, the extent to which we have been affected by the American war, in the cost of raw material, alone. In 1860, our imports of cotton, from America, only, were 9,963,309 cwts., and to these we added 2,455,787 cwts. from other parts of the world, the value of the whole being £35,756,889. In 1863, we imported from all countries only 5,978,422 cwts.; but the cost was £56,277,953, showing a rise in price of not less than 158 per cent. How much of the sum of £2,897,998, which we paid in enhanced prices for our fibrous material, in one year, only, might have been saved, had due attention been given to the sources of supply that are open to us, both East and West, it is impossible to say; but that a very large portion of it would have been saved, there is no doubt; and all the branches of trade connected with textile industry, as well as the nation at large, would have been proportionately benefited.*

There is as fine material still to be got from an almost countless variety of vegetable products, in both hemispheres, as ever yet passed through the loom; and how great an impetus would be given to trade and commerce by a

* The official accounts of the Board of Trade, for the six months ended June 30, 1864, show a large increase in our importations of fibre, during the six months closing with that date, compared with the corresponding period of 1863:—

	Six Months ending June 30, 1863. Cwts.	Six Months ending June 30, 1864. Cwts.
Raw Cotton	2,134,230	3,546,968
Flax	466,564	878,674
Hemp, &c.	318,163	331,145
Jute	561,069	1,266,028
Materials for Paper	186,020	682,440
Total	3,666,046	6,705,255

But prices rule as high as they did last year.

more abundant supply of it, in a condition suitable for the manufacture of muslin, cloth, cordage, canvas, rope, paper, &c., every one can readily perceive, as also how greatly our Indian possessions would be benefited thereby. Already, the cultivators of the soil there, are reaping, in a very large degree, the benefits resulting from an increased cultivation and exportation of cotton, which can, under no circumstances, be other than a small proportion of the fibrous substances of a high quality which would undoubtedly be exported thence, if the proper methods of preparing them were introduced.

If, as Dr. Watson has stated, the Government is desirous of directing attention to these prolific sources of fibrous wealth, I do not know how they could better do it than by making such an exhibition of the products as that I have suggested. They would thus encourage practical experiments for discovering the readiest and cheapest methods of preparing them for spinning.

No one process can be adapted for the treatment of all descriptions of fibre. There is a wide sphere for the investigations and experiments of science; and an exhibition of what fibres we have, and of what we have done towards rendering them useful for the purposes for which Nature appears to have designed them, would go far towards stimulating further improvements. Up to this time, little has been done in this way. If you inquire for specimens of fibre at the Kensington Museum, you are told that they have none there—that you must seek them at Kew. You go to Kew, and in those magnificent gardens you will find brought together the entire family of Palms—"kings among the grasses"—a collection of which Sir William Hooker may be justly proud, since it is unequalled in Europe. There will also be found many other fine specimens of tropical plants, interesting to the botanist, and to all who love to examine the wonders of Nature. There are likewise some specimens of fibre, of various kinds, in the museums; but they can only be looked at as objects of curiosity. The India Museum, at Whitehall, is much richer in specimens of fibre, and, thanks to the intelligent labours of Dr. Forbes Watson, they are exhibited under as favourable circumstances as they could be in a museum which comprises so multifarious and interesting a collection of objects. But what I have said about trade museums, applies with increased force to the India Museum, and will apply to any museum which is not exclusively appropriated to the fibrous products of the vegetable world.

I am not losing sight of our own products; I mean of those cultivated in the United Kingdom—*i.e.*, flax and hemp. All I have said of the importance of improved methods of treating exotic fibres applies equally to those which we ourselves produce. Indeed, I feel that it is impossible to exaggerate the importance of improved methods of treating these vegetable productions, in order to obtain the fibre in the best condition as to strength and the other qualities that fit it for textile manufactures of a superior character—such as linens, muslins, &c.—as well as for working up with silk, wool, alpaca, &c. Let me just advert to the article of flax, for example.

The present consumption of this fibre in the United Kingdom is estimated at 160,000 or 170,000 tons a year, of which about 70,000 are grown in England and Ireland—by far the larger part of it in the last-named portion of the kingdom. By the ordinary method of water-retting, the fibre is obtained from the grass in the proportion of about one part in ten. By some other methods it is obtained in the proportion of one part in seven or eight. That is to say, ten tons of straw produce one ton of flax, as the result of water-retting; seven or eight tons of straw produce one ton of flax as the result of some of those improved methods which science has discovered. It cannot be denied, however, that the quality of the fibre, in substance and strength, is, as produced by the hot-water methods of preparing it, by far below what it should be. It is deprived not only of the gummy or glutinous substance which attaches to it in its natural state, but of a good deal of that inherent property which constitutes its real value.

The discovery of a process which will produce one-fifth of the weight of the grass in fibre—that is to say, which will get one ton of fibre out of five tons of grass; and get it in a purer condition or more perfectly freed from all extraneous and deteriorating matter, and necessarily stronger, therefore—seeing that the strength of the fibre is in proportion as it is free from the resinous substance which originally adheres to it—must be a great gain.

But let it be stated that a method of treatment has been discovered, by which 50 per cent. of fibre is gained, its quality being only equal to the quality of that obtained by the best methods of preparing it hitherto known. Upon the 500,000 tons of grass now probably used in the United Kingdom, there would be a gain of more than 33,000 tons of fibre. At £55 per ton, only, this would yield a profit of

more than £1,800,000, over and above that now obtained. But the flax will be of a much better quality than this price assumes, and will realize in the market an average price of £70 per ton; thus yielding an excess over the present produce of the flax grown in the United Kingdom of £2,310,000 a year.

Other fibres may be treated in the same way, with slight modifications adapted to their peculiarities. Hemp, Jute, China grass, Manilla hemp, Sisal hemp, New Zealand hemp, Japan hemp, and many other fibres imported into this country, some of them in a condition not at all fit for textile manufactures, and others of them but badly fitted for such purposes, are all capable of being so far improved in the qualities of strength, fineness, flexibility, &c., as to place them amongst the most desirable materials for the loom. and to increase their market value from 50 to 100 per cent.

It might be thought that those who are more immediately interested in the textile manufactures of the United Kingdom should have done something towards the accomplishment of such an object as I have ventured to suggest. Geologists have their museum for the exhibition of earths, and stones, and other objects pertaining to their science. Zoologists and Botanists have their Gardens and Museums, in which they collect and exhibit such specimens as they can procure of those works of Nature which tend to promote a knowledge and love of their respective sciences. If the value of things is to be measured by their utility, the fibrous products of Nature do not rank the lowest; and if the wisdom of those who are immediately interested in them is to be tested by the efforts they make to increase their numbers and quantities, and to improve their capability of being applied to the purposes of man's comfort and enjoyment, then manufacturers and others who convert them into such things as art and science have hitherto succeeded in rendering them available for, are not the wisest in their generation.

What Dr. Royle said on behalf of the investigations promoted by the Society of Arts, I take the liberty of applying, with but a slight modification to such an Institution as I propose. Such an exhibition of fibrous products as would be made in a museum specially appropriated to them, and which would be a standing and continuous invitation to the world to contribute to its objects, though it may not, at first sight, appear practical, would be of great use in enabling the inquiring and intelligent manufacturer to

become acquainted with the properties and probable quantities of new substances. The broker would be able to say something more respecting them than that "they are unknown in the market," and therefore of no value. As a further consequence, the local merchant or capitalist abroad would be able to purchase, or make advances, on what there is some probability of selling at reasonable prices in foreign markets. Finally, the European planter, or native cultivator, would be encouraged to grow or to prepare what appears to him of the greatest value, because it finds a local purchaser; for he has little or no knowledge of what is of value in the foreign market. Any one of the points of this circle of connexions being ommitted, is sufficient, as has often been experienced, to put a stop to progress in a new course. Such inquiries would, moreover, be of especial utility, if carried on in connexion with an Institution where everything would have the advantage of being submitted to the examination of men, who, by their scientific attainments and practical knowledge, are the best qualified to form a correct judgment on the value of unknown products, or of the new inventions brought before them; for it is only by the union of scientific with practical knowledge that any great results are, in the present day, to be obtained. If we rely upon practical knowledge only, we may, when apparently proceeding at railway speed, be brought to a sudden, and occasionally disastrous, termination, by the neglect of some single point; while, if we rely upon science only, we may often be shunted off, though we can avail ourselves of legitimate modes for returning to the course we were wishing to pursue.

Professor Solly, whom I have already quoted, enumerates, as among the benefits resulting from the International Exhibition, that it is not merely a record of the successes, but also, to some extent, likewise, of the failures, of past years; and there are many cases, as he observes, in which failures are even more instructive than successes. In examining those materials that had been brought over in former years, and which had been condemned and discarded because they never came under the notice of proper persons, or because no pains were taken to apply them in the right manner, but which are now beginning, probably from some accident, to excite attention, "we are naturally led to inquire into the reasons why they met with so little favour; we are induced to study the modes in which they were tried, and the causes which led to the

failure of their employment. If these inquiries teach us the reason why former attempts failed, they may very probably suggest new modes of working, better suited to the properties and peculiar characters of each substance; or, indeed, they may perhaps lead to altogether new uses and new applications."*

In how much greater a degree these advantages would be likely to result from a permanent than from a temporary Exhibition, I need not attempt to point out.

I have no direct interest in the extended use of fibres; but I have for many years, as already stated, applied myself to the investigation of their peculiar qualities, and to experiments for rendering them as perfect as possible for manufacturing purposes, especially for spinning and weaving. I have a tolerably large and varied collection of European and tropical fibres, which show into what a fine condition many of those hitherto confined to the manufacture of rope and coarse canvas may be brought by proper treatment—a condition which fits them for producing the most delicate as well as the strongest and most durable fabrics. I shall be glad to enlarge the collection, and to present it as a contribution towards a Fibre Museum. Everything must have a beginning, and I do not doubt that this small collection would soon receive such accessions, that, before long, a most extensive collection would be formed, and become the basis of what might justly be looked upon as a national exhibition.

The suggestions I have thrown out on this subject are no doubt very crude; but if they should have the effect of directing other minds, better capable of realizing what appears to me to be most desirable, to a consideration of it and of the means for accomplishing it, my object will be answered, and I shall experience much gratification in the result.

9, *Hunter Street,*
Brunswick Square, W.C.
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* "Lectures on the Results of the Great Exhibition," p. 251.

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